US009385500B2

(12) **United States Patent**
Goossens

(10) **Patent No.: US 9,385,500 B2**
(45) **Date of Patent: Jul. 5, 2016**

(54) **ELECTRICAL CONNECTOR INCLUDING FINS**

(71) Applicant: **Thierry Goossens**, Herdersem-Aalst (BE)

(72) Inventor: **Thierry Goossens**, Herdersem-Aalst (BE)

(73) Assignee: **FCI ASIA PTE. LTD.**, Singapore (SG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 29 days.

(21) Appl. No.: **14/463,792**

(22) Filed: **Aug. 20, 2014**

(65) **Prior Publication Data**

US 2015/0056868 A1 Feb. 26, 2015

Related U.S. Application Data

(60) Provisional application No. 61/870,030, filed on Aug. 26, 2013.

(51) **Int. Cl.**

H01R 13/73	(2006.01)
H01R 43/26	(2006.01)
H01R 12/72	(2011.01)
H01R 107/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 43/26*** (2013.01); ***H01R 12/724*** (2013.01); *H01R 2107/00* (2013.01)

(58) **Field of Classification Search**

CPC H01R 13/73
USPC 439/79, 572, 947, 934
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,158,471	A *	10/1992	Fedder	H01R 9/091 439/65
5,928,035	A	7/1999	Jankowsky	
6,299,480	B1	10/2001	Xu et al.	
6,354,875	B1	3/2002	Wu	
6,498,708	B2	12/2002	Schilloff et al.	
6,563,056	B1	5/2003	Belwon et al.	
6,733,301	B2 *	5/2004	Brown, III	H01R 12/585 439/65
6,780,054	B2	8/2004	Yip et al.	
7,139,177	B2	11/2006	Gottlieb	
7,314,377	B2 *	1/2008	Northey	H01R 12/777 439/79
7,344,395	B2	3/2008	Agethen et al.	
7,497,731	B2	3/2009	Rosenfeldt et al.	
7,666,025	B2 *	2/2010	Cheng	H01R 12/7088 439/374
7,976,317	B2	7/2011	Patel et al.	
2011/0111608	A1	5/2011	Chen et al.	
2011/0281462	A1	11/2011	Tonosaki	
2012/0262895	A1	10/2012	Quek	

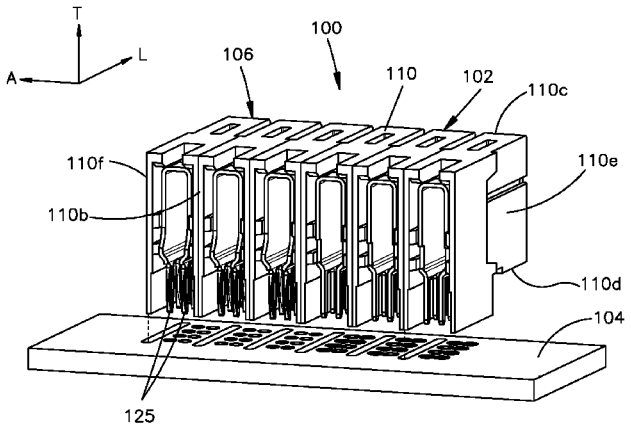
* cited by examiner

Primary Examiner — Phuong Dinh
(74) *Attorney, Agent, or Firm* — Baker & Hostetler LLP

(57) **ABSTRACT**

An electrical connector can be configured to mate with at least one complementary electrical connector. The electrical connector includes a dielectric connector housing including a housing body that defines a mounting interface configured to be mounted onto a substrate and a mating interface configured to receive at least one complementary electrical connector along a mating direction. A plurality of electrical contacts are supported by the connector housing and spaced apart from each other along a lateral direction that is substantially perpendicular to the mating direction. The electrical contacts include 1) a mating portion that is configured to mate with a complementary electrical contact of the complementary electrical connector, and 2) a mounting portion configured to electrically connect to the substrate. The electrical connector can further include at least one electrically insulative fin supported by the housing body.

24 Claims, 13 Drawing Sheets



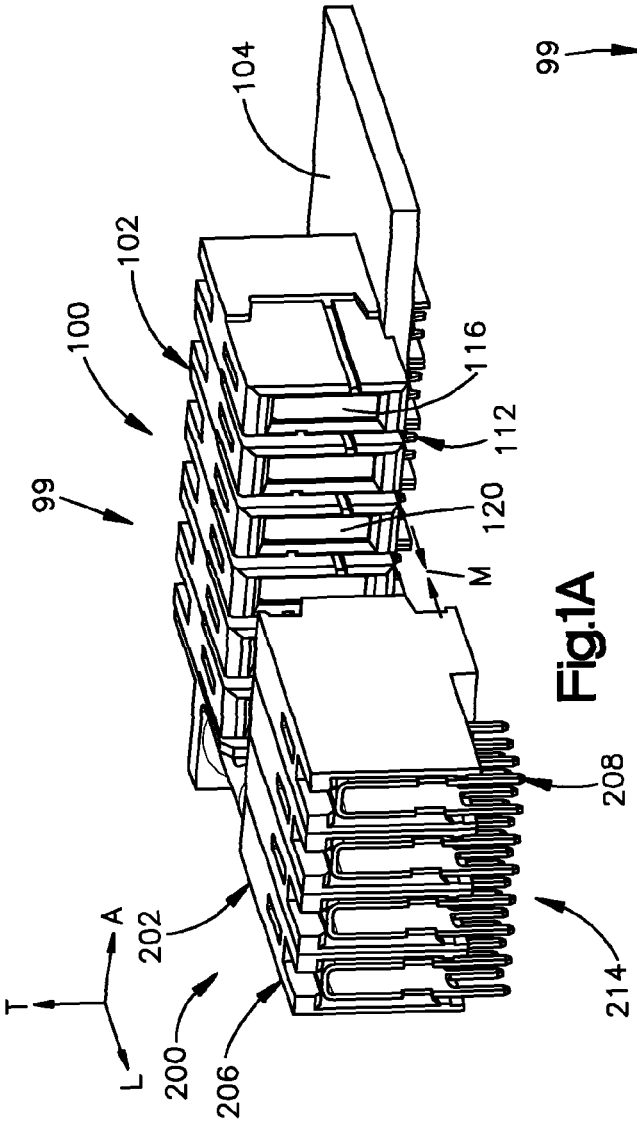

T
A
L
202
200
206
214
208
99
100
102
104
116
112
120
M

Fig.1A

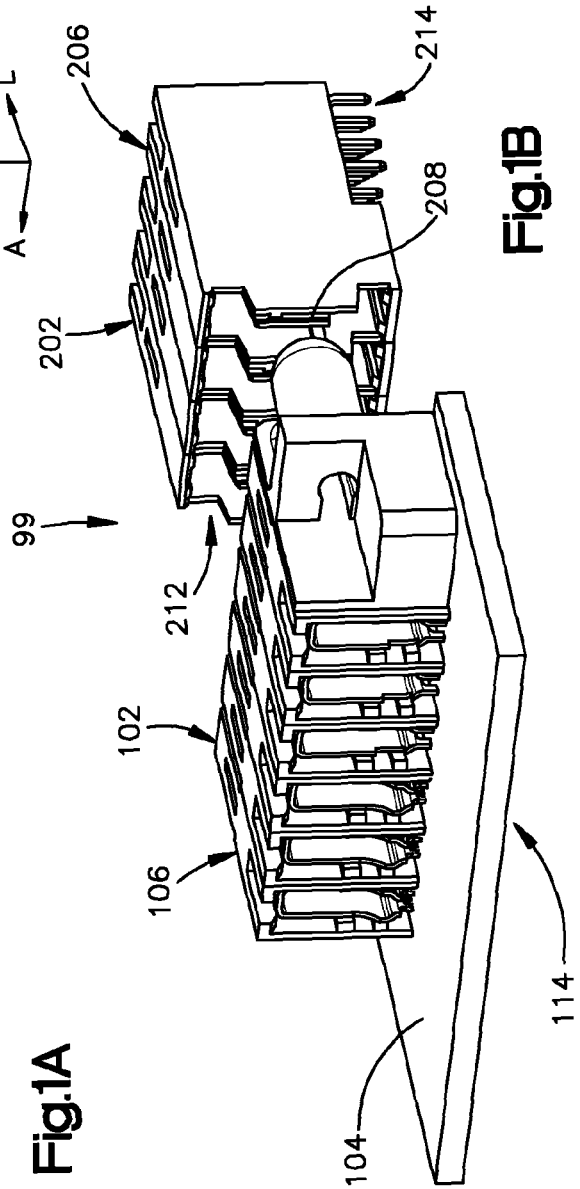

T
A
L
206
214
208
202
99
212
102
106
104
114

Fig.1B

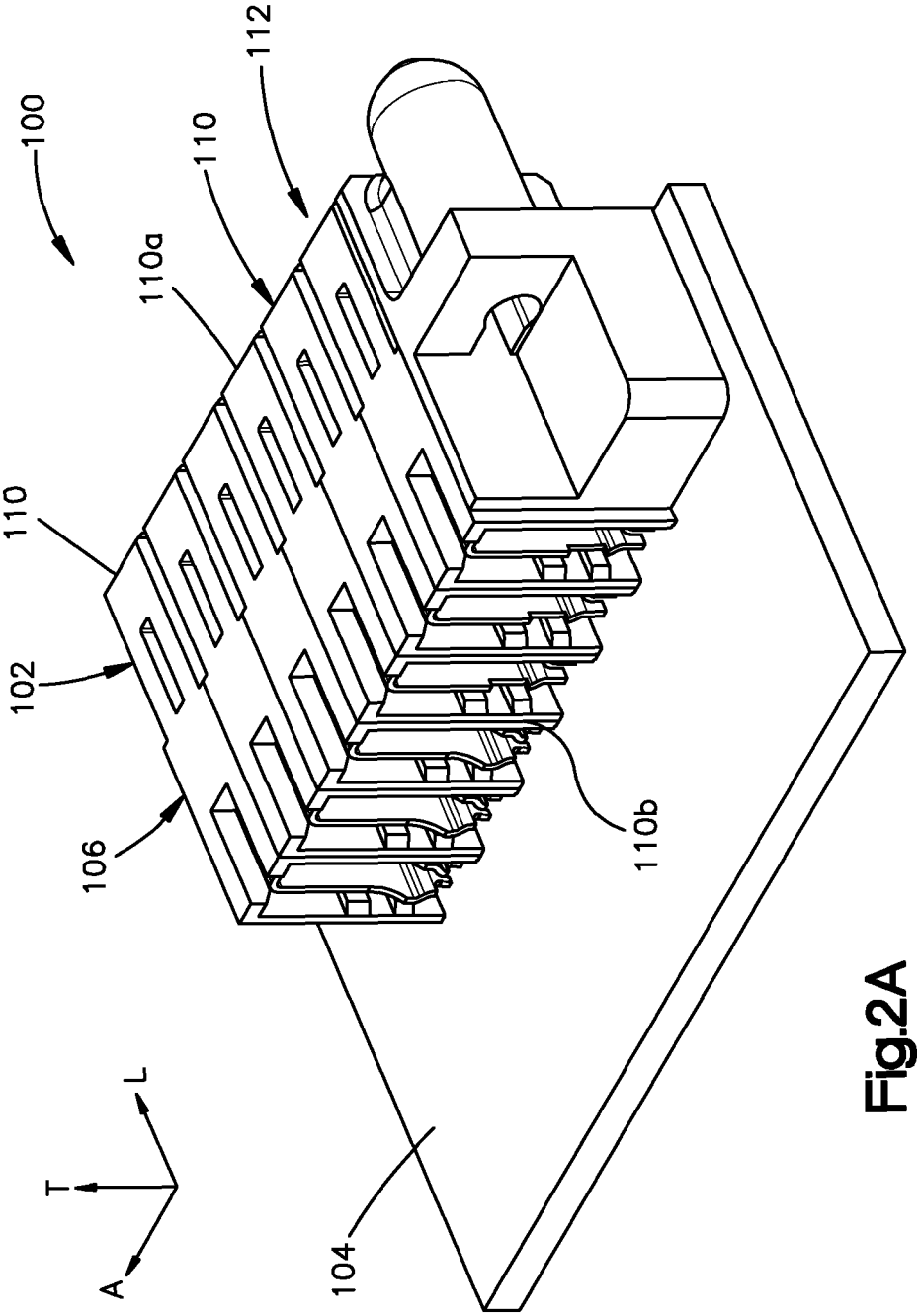


Fig.2A

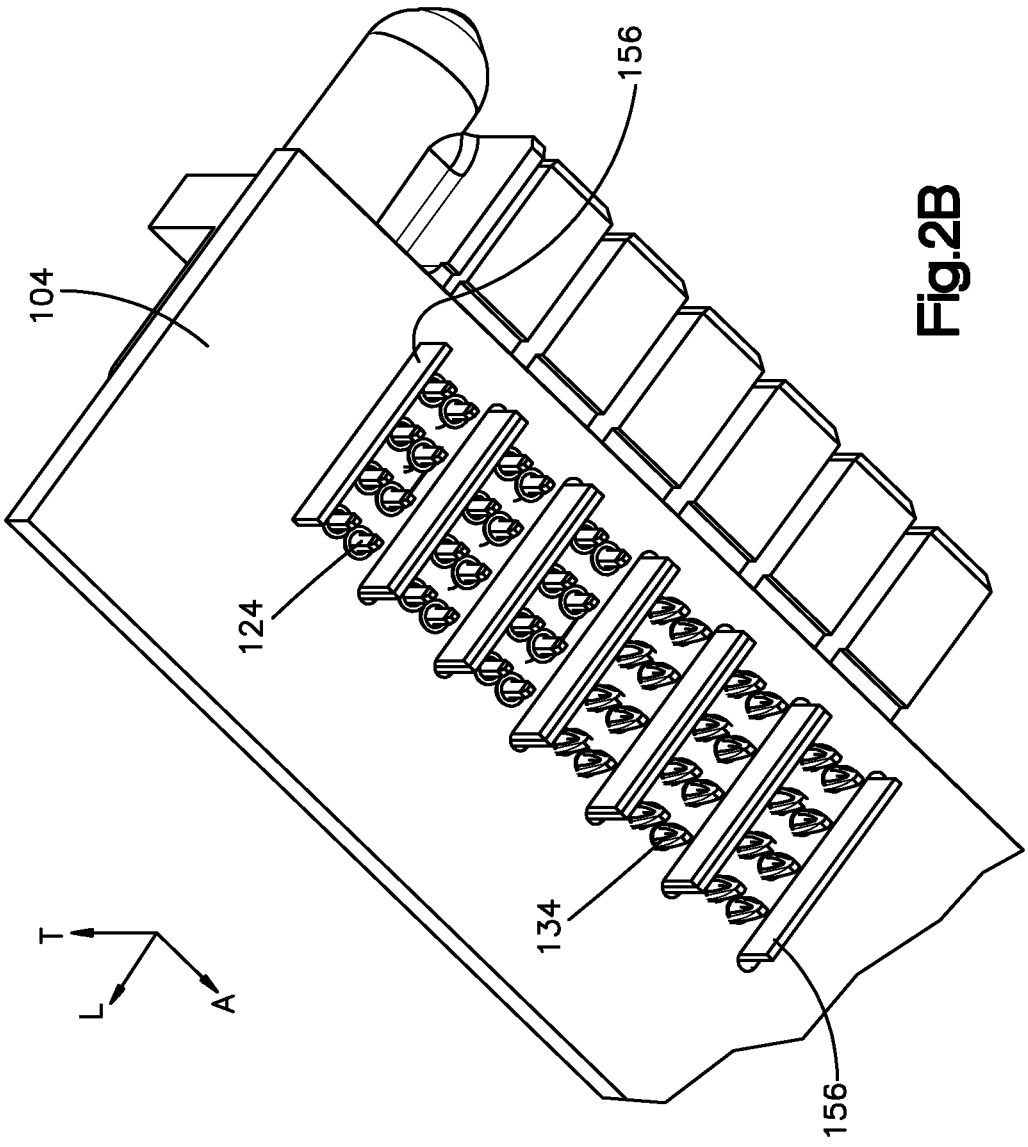


Fig.2B

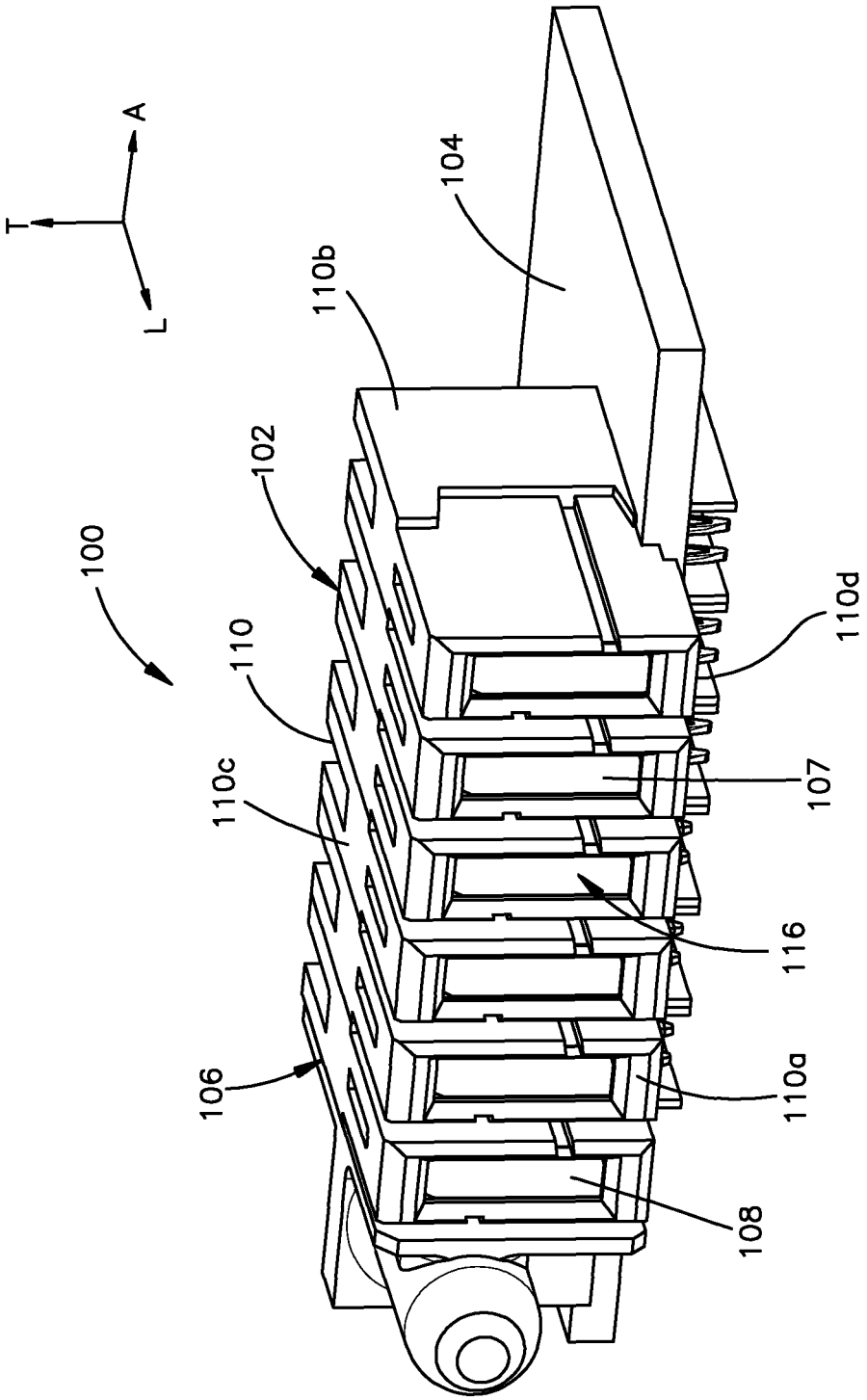


Fig.2C

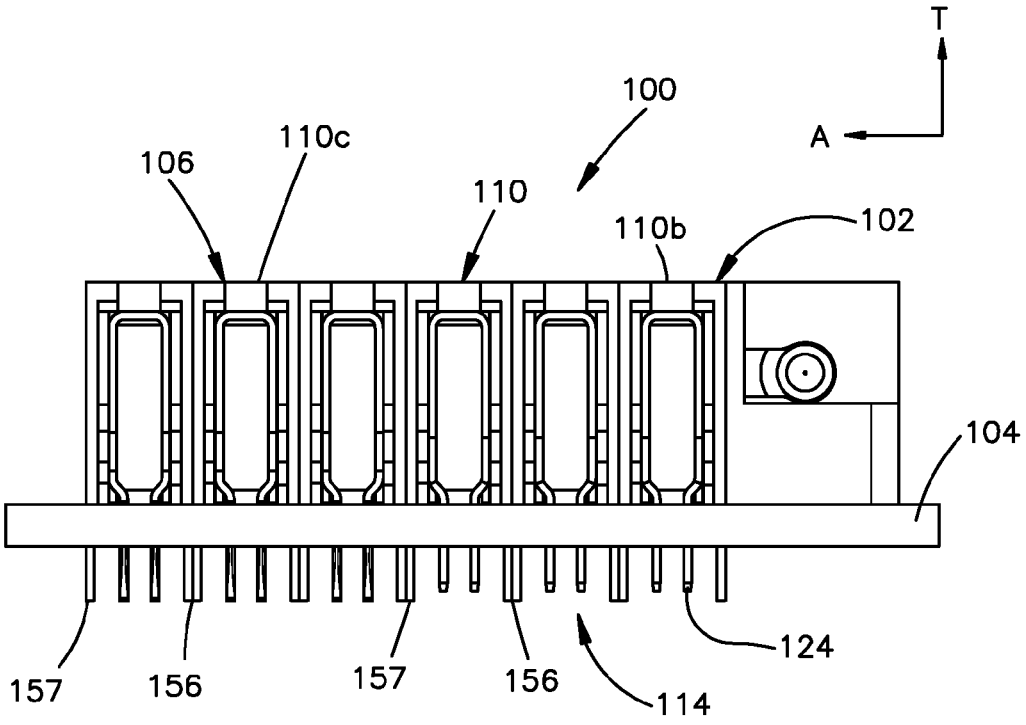

T
A
100
110c
106
110
110b
102
104
157
156
157
156
114
124

Fig.2D

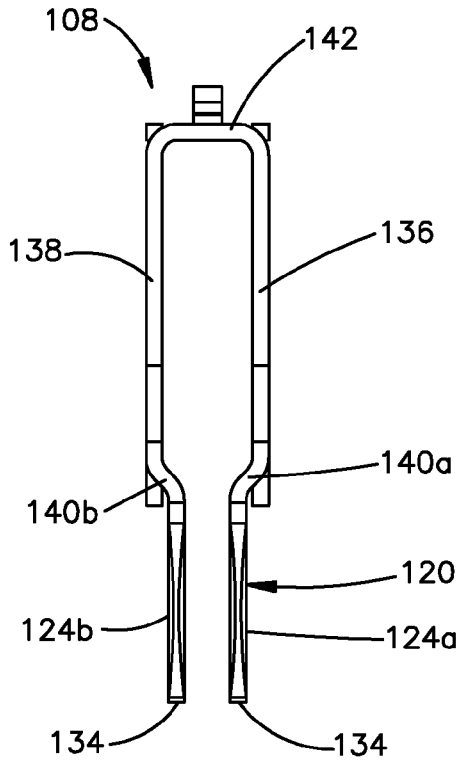

108
142
138
136
140a
140b
120
124b
124a
134
134

Fig.3A

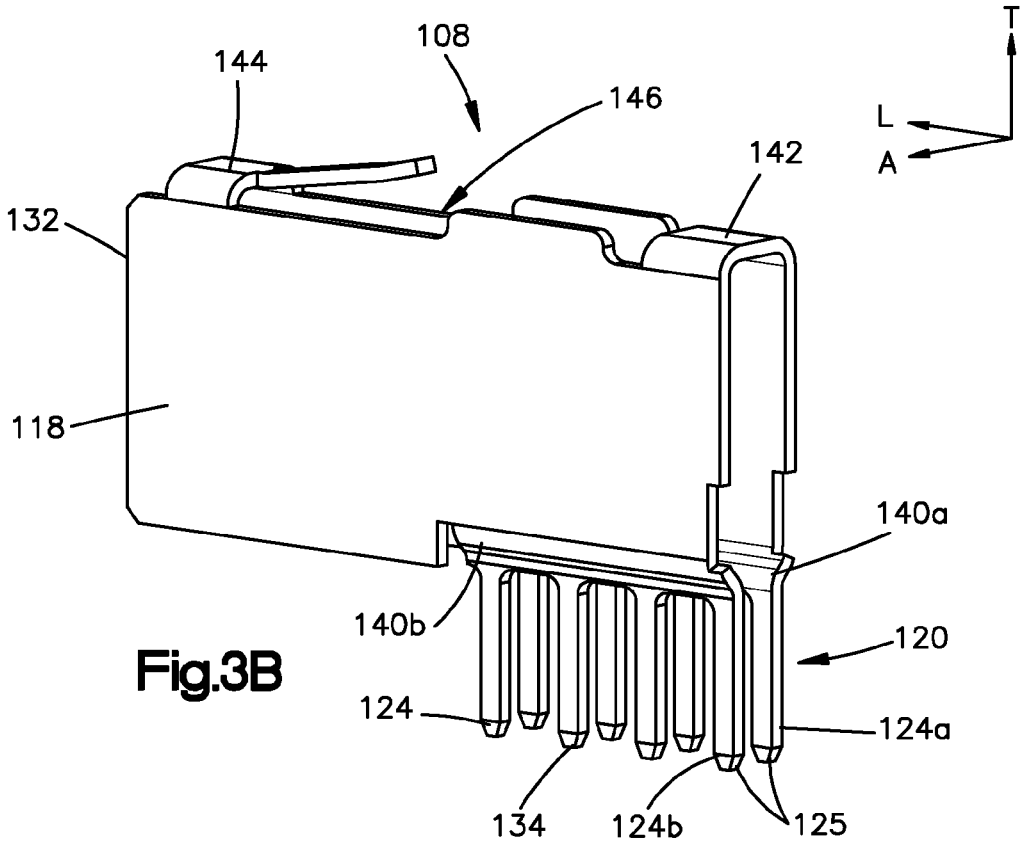

T
L
A
108
144
146
142
132
118
140a
140b
120
124
124a
134
124b
125

Fig.3B

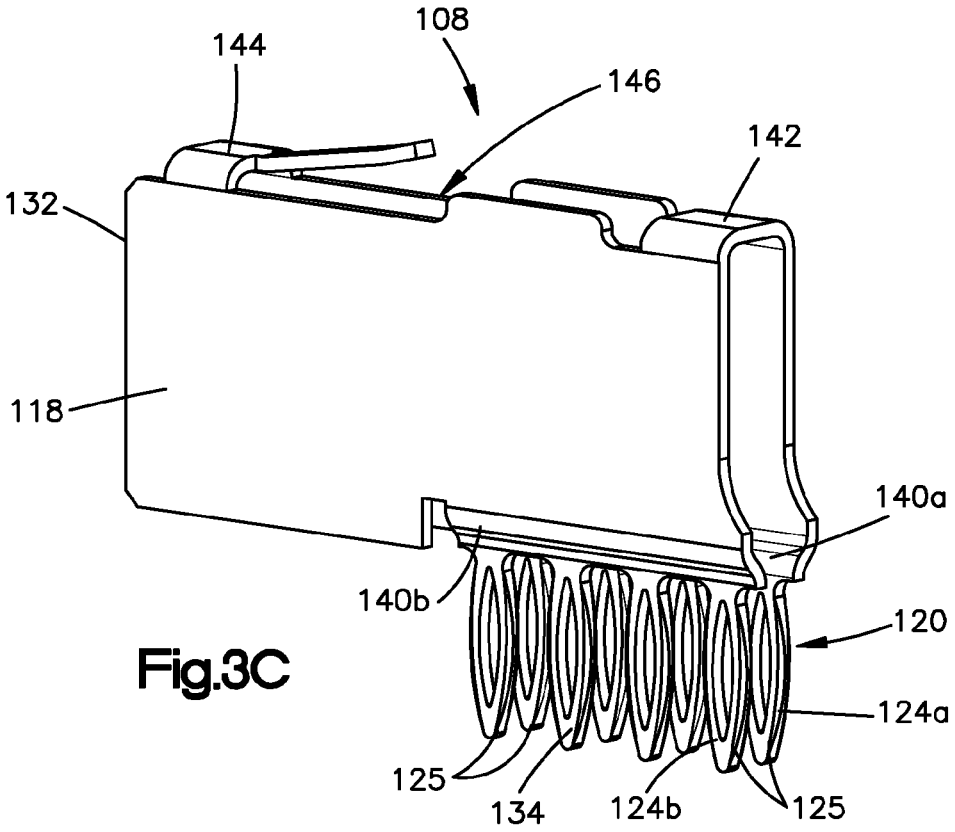

108
144
146
142
132
118
140a
140b
120
124a
125
134
124b
125

Fig.3C

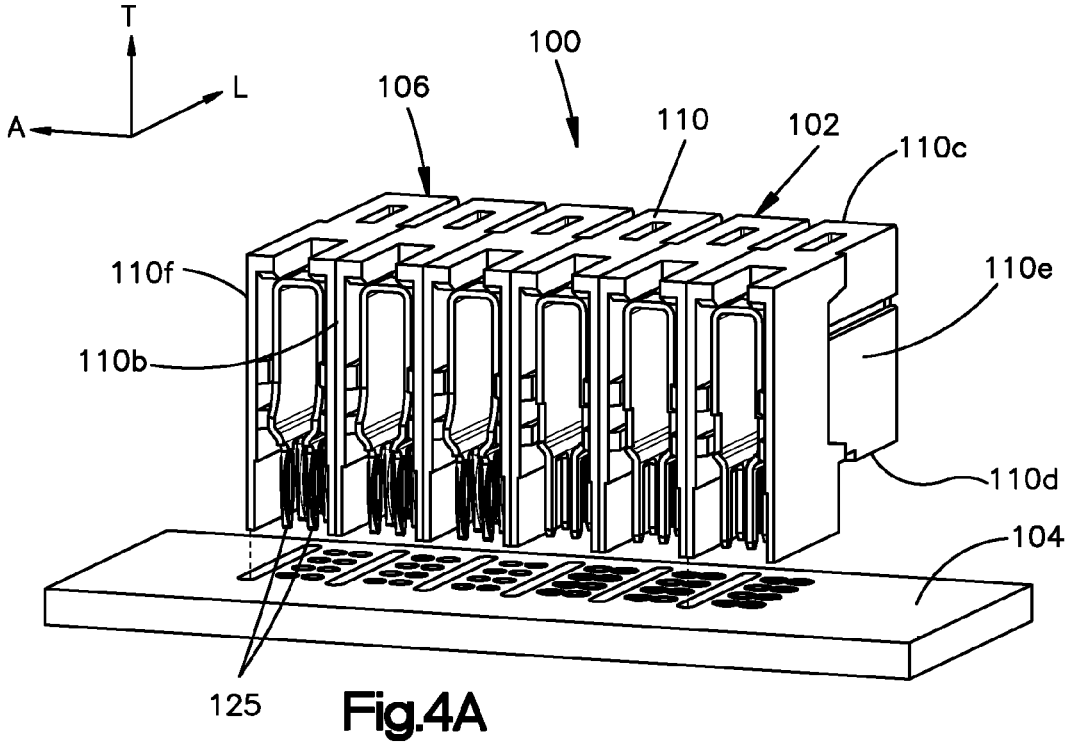

T
L
A
100
106
110
102
110c
110f
110e
110b
110d
104
125

Fig.4A

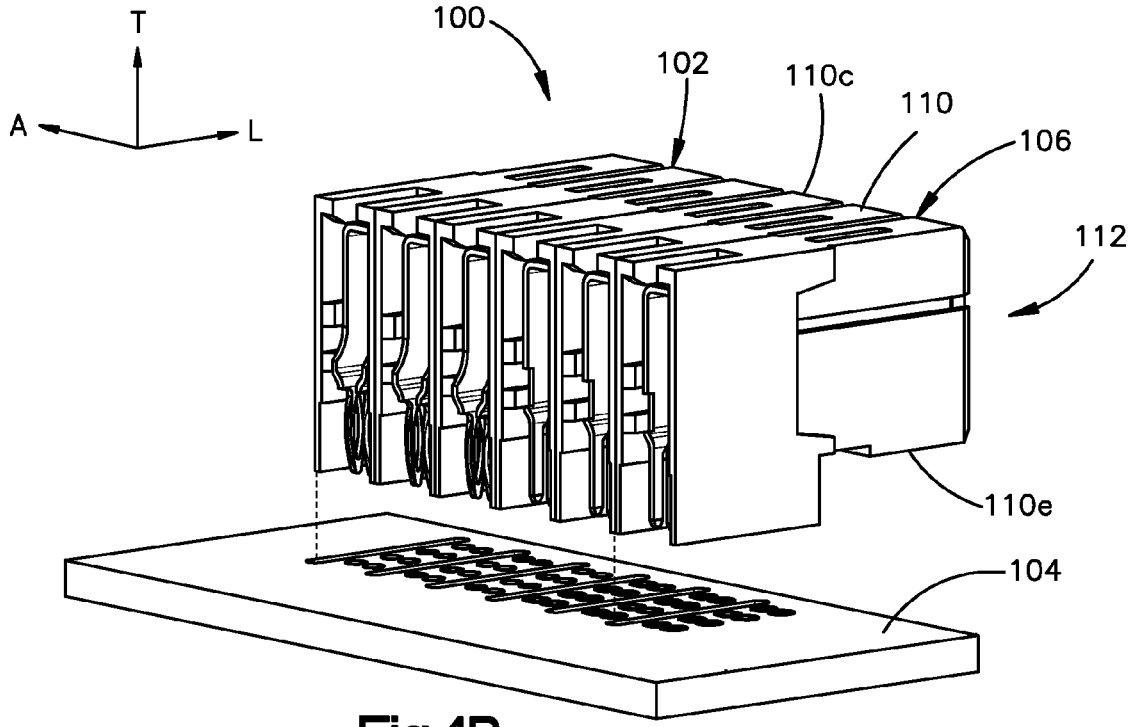

T
A
L
100
102
110c
110
106
112
110e
104

Fig.4B

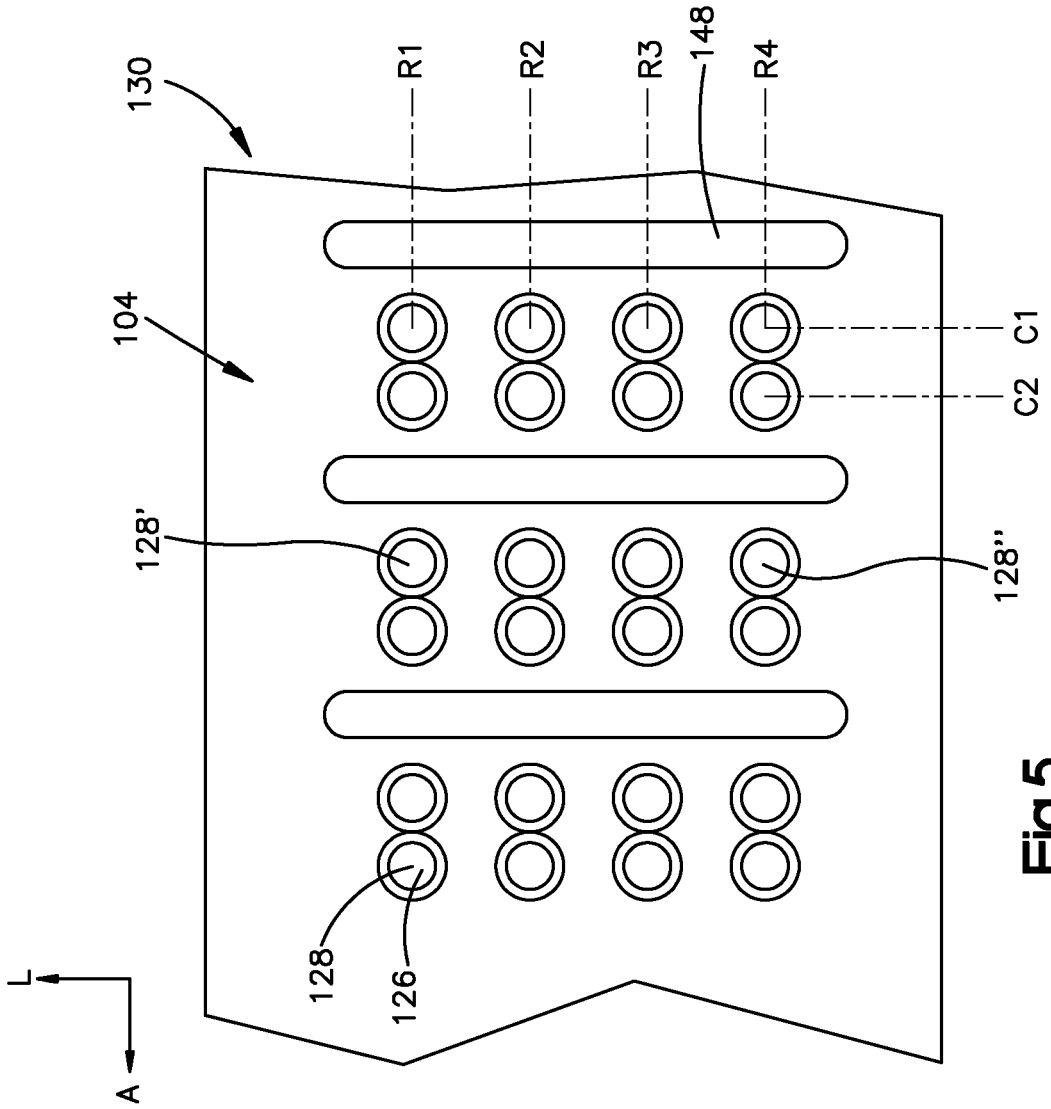


Fig.5

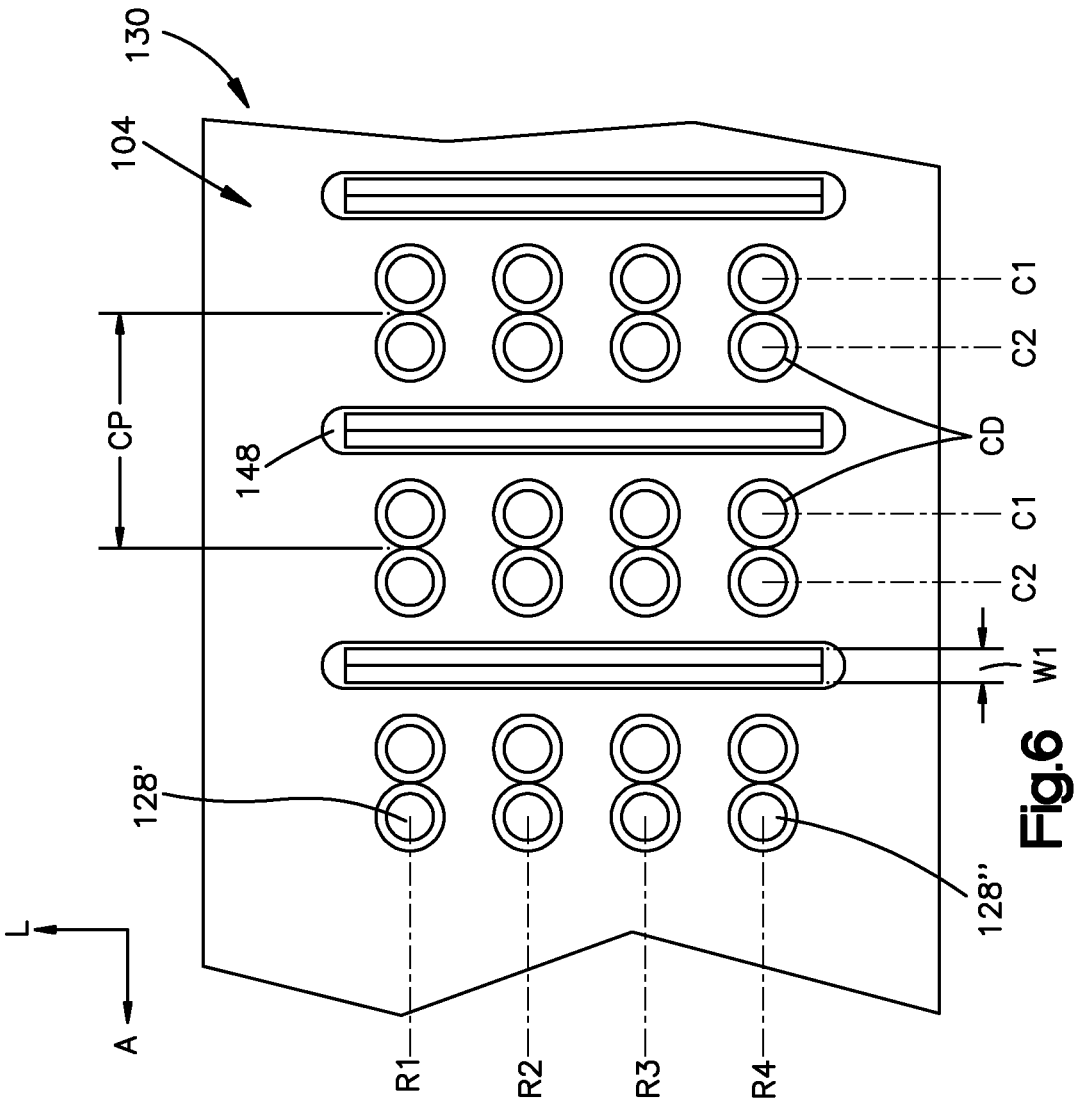


Fig.6

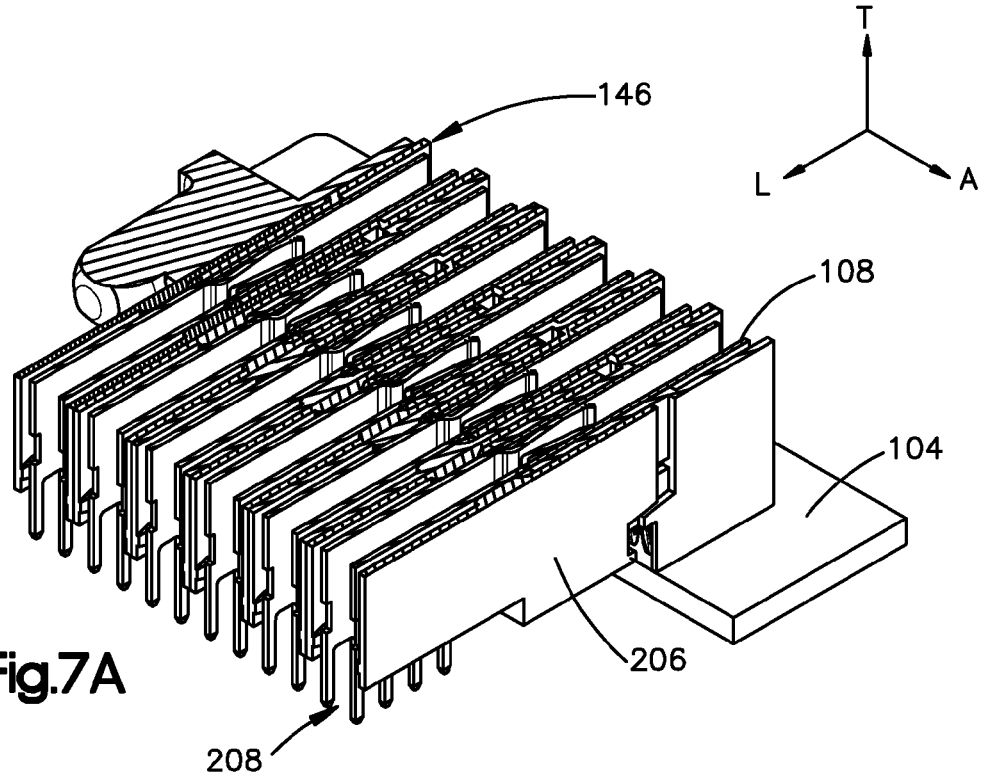

T
L
A
146
108
104
206
208

Fig.7A

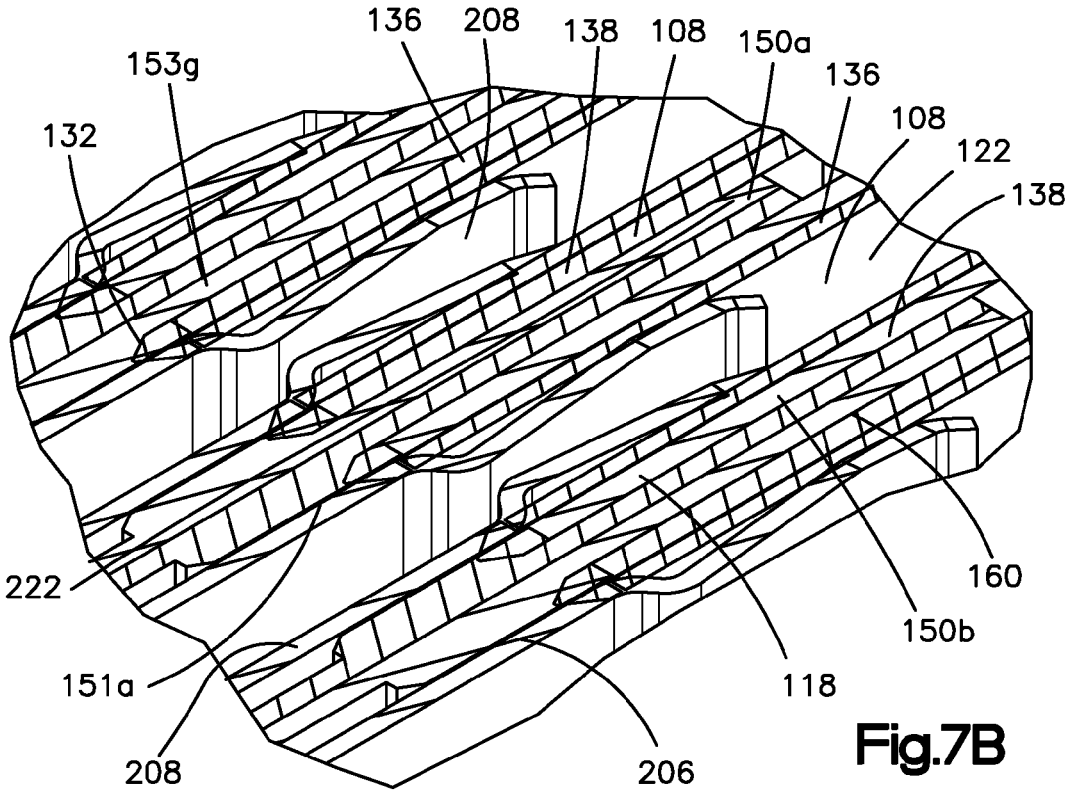

136
208
138
108
150a
153g
136
132
108
122
138
222
160
150b
151a
118
208
206

Fig.7B

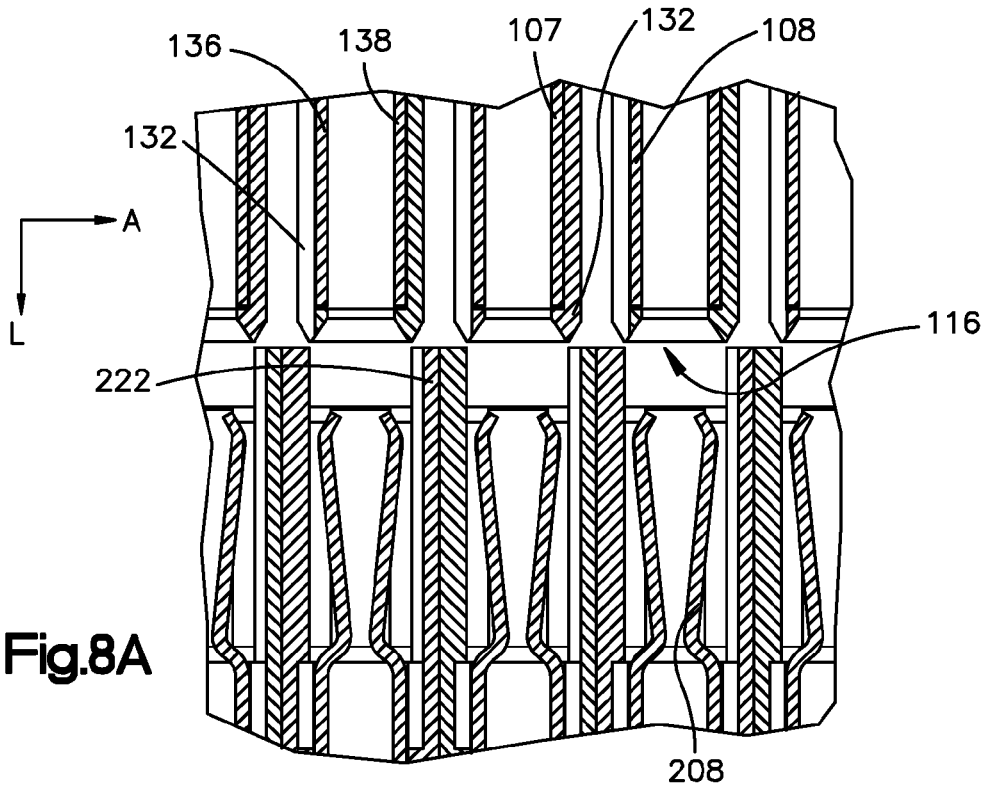

136
138
107
132
108
132
A
L
116
222
208

Fig.8A

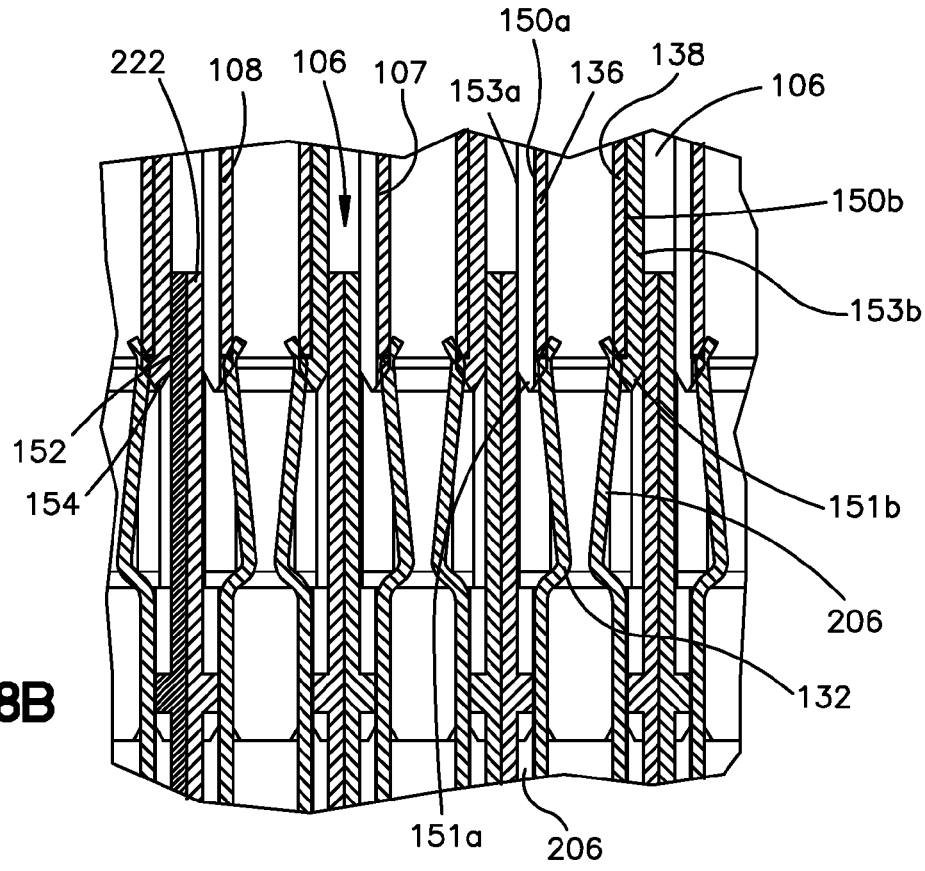

150a
222
108
106
107
153a
136
138
106
150b
153b
152
154
151b
206
132
151a
206

Fig.8B

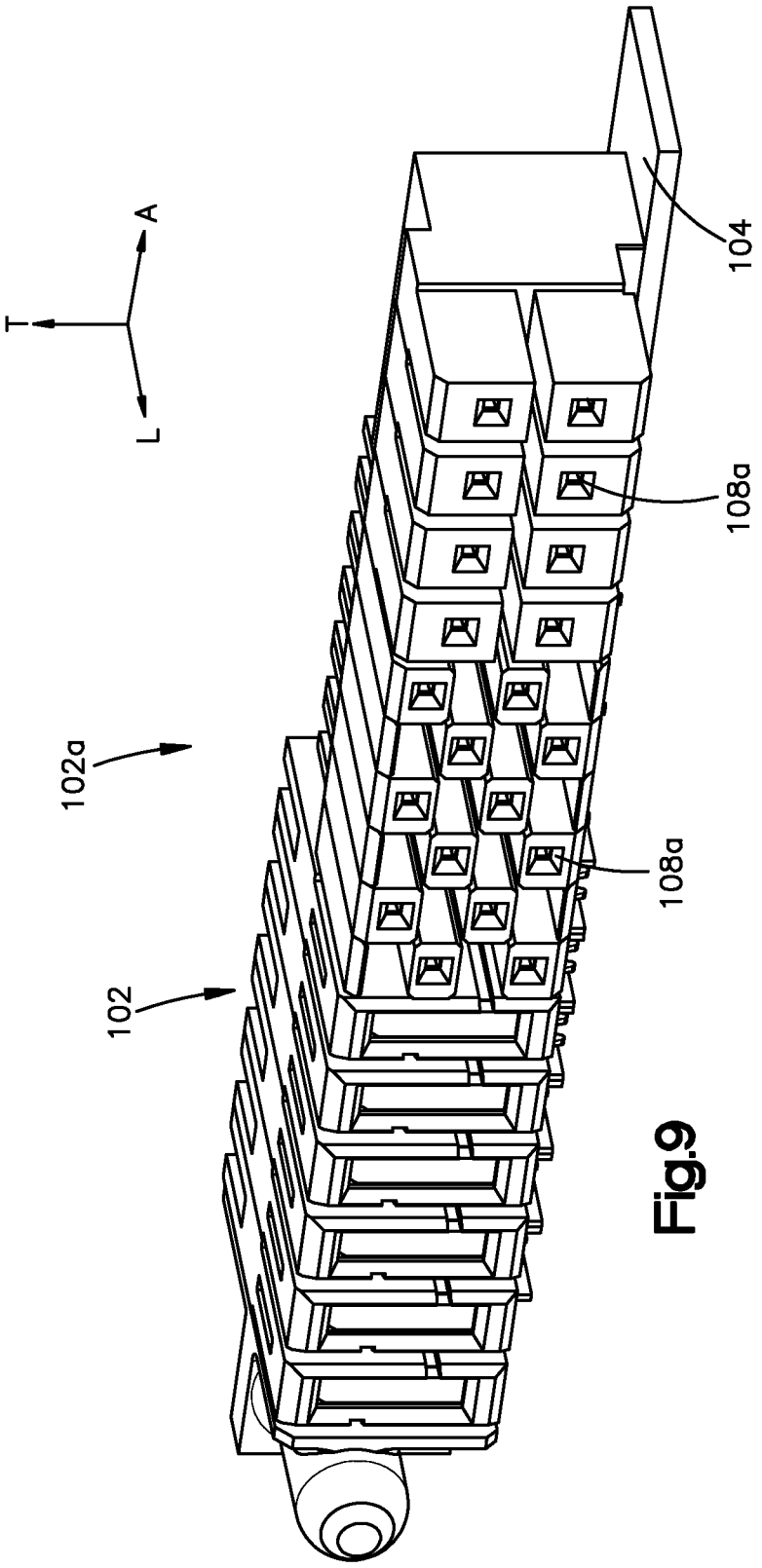


Fig.9

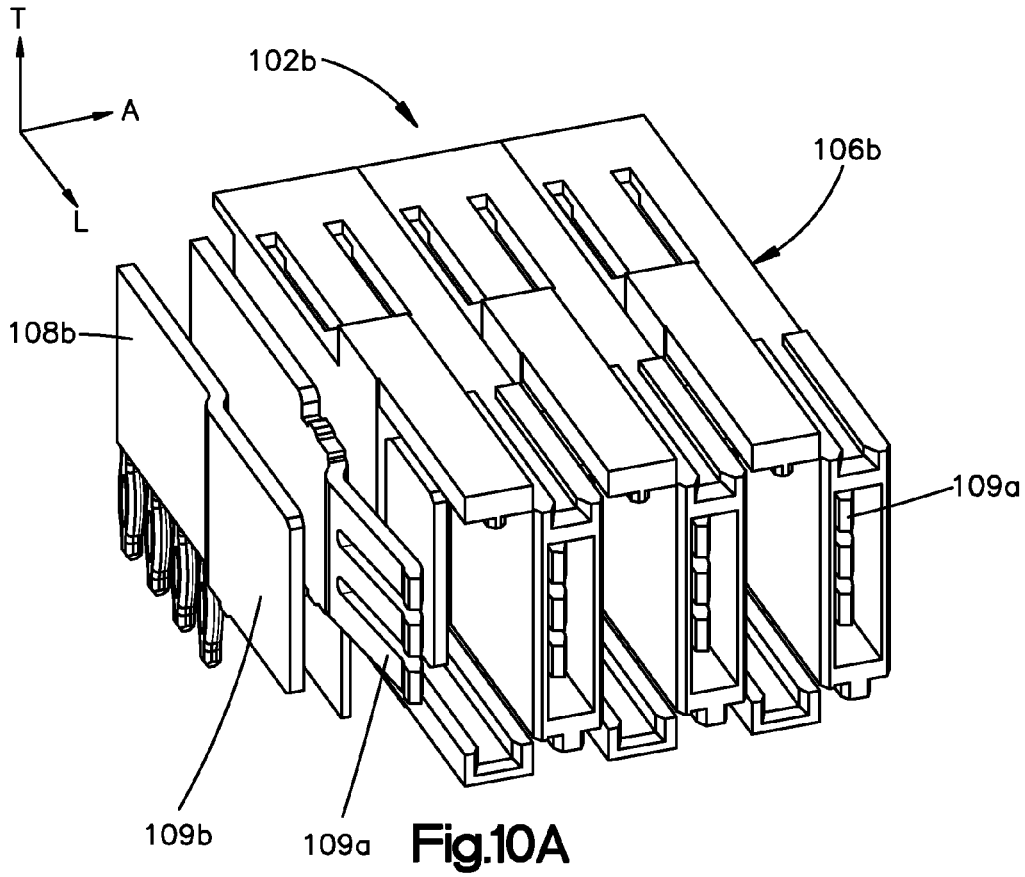


Fig.10A

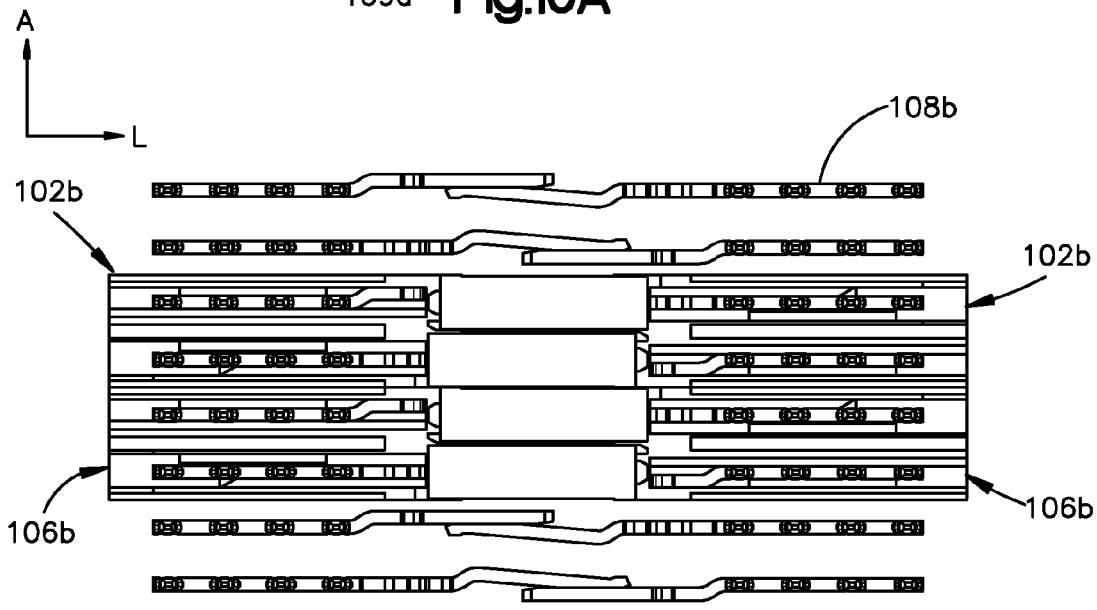


Fig.10B

ELECTRICAL CONNECTOR INCLUDING FINS

CROSS REFERENCE TO RELATED APPLICATIONS

This Application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/870,030, filed Aug. 26, 2013, the disclosure of which is hereby incorporated by reference as if set forth in its entirety herein.

BACKGROUND

Electrical connectors used to transmit data signals and/or electrical power, such as alternating current (AC) power and/or direct current (DC) power, may include a plurality of power contacts and a plurality of signal contacts mounted in an electrically insulative housing. In a typical application, the connector may be configured to be mounted onto a substrate, such as a printed circuit board, and configured to mate with a complementary electrical component, which can be a power cable or complementary electrical connector, for example. Specifically, each contact within the housing may include one or more header and/or receptacle contacts that mate with opposed receptacle and/or header contacts, respectively, of the complementary electrical component.

A typical contact includes multiple terminals or pins extending from a bottom portion for electrically connecting the contact to a substrate, such as a printed circuit board. In the case of power contacts, high voltage levels traveling through the terminals can produce arcing across the terminals, which can also be referred to as leaking or creeping. It is known, therefore, that under otherwise constant conditions, for instance the same substrate material and the number of terminals, spacing the terminals away from each other can reduce the instances of arcing. However, spacing the terminals farther apart while maintaining the number of terminals adds to the overall footprint of the connector, thereby occupying valuable space on the circuit board.

SUMMARY

In accordance with one embodiment, an electrical connector is configured to mate with at least one complementary electrical connector. The electrical connector includes a dielectric connector housing including a housing body that defines a mounting interface configured to be mounted onto a substrate and a mating interface configured to mate with at least one complementary electrical connector along a mating direction. A plurality of electrical contacts are supported by the connector housing and spaced apart from each other along a lateral direction that is substantially perpendicular to the mating direction. The electrical contacts include 1) a mating portion that is configured to mate with a complementary electrical contact of the complementary electrical connector, and 2) a mounting portion configured to electrically connect to the substrate. The electrical connector can further include at least one electrically insulative fin supported by the housing body. The fin can be disposed between first and second electrical contacts of the plurality of electrical contacts along the lateral direction. The mounting portion of each of the first and second electrical contacts can terminate at a mounting end that is spaced from the housing body a first distance along the transverse direction that is perpendicular to each of the mating direction and the lateral direction. The at least one fin can extend from the housing body along the transverse direction and can terminate at a distal end that is spaced from the housing body a second distance along the transverse direction, wherein the second distance is no less than the first distance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a perspective view of an electrical connector system constructed in accordance with one embodiment including an electrical connector assembly that includes an electrical connector mounted to an underlying substrate, wherein the electrical connector assembly is aligned for mating with a complementary electrical connector;

FIG. **1**B is another perspective view of the electrical connector system shown in FIG. **1**A;

FIG. **2**A is a perspective view of the electrical connector assembly shown in FIG. **1**, wherein the electrical connector includes a connector housing and a plurality of electrical contacts that are at least partially disposed within the connector housing;

FIGS. **2**B-C are other perspective views of the electrical connector assembly shown in FIG. **1**;

FIG. **2**D is a rear elevation view of the electrical connector assembly shown in FIG. **1**;

FIG. **3**A is an isolated rear elevation view of one electrical contact of the plurality of electrical contacts shown in FIG. **2**A;

FIG. **3**B is a perspective view of another embodiment of the electrical contact shown in FIG. **3**A;

FIG. **3**C is a perspective view of the electrical contact shown in FIG. **3**A;

FIGS. **4**A-B are perspective views of the electrical connector shown in FIG. **2**A, wherein the electrical connector is aligned to be mounted to the underlying substrate;

FIG. **5** is a bottom plan view of the a portion of underlying substrate shown in FIG. **2**A;

FIG. **6** is the bottom plan view of the portion of the underlying substrate show in FIG. **2**A, wherein only the connector housing of FIG. **2**A is mounted to the substrate;

FIG. **7**A is a cross-section of a perspective view the electrical connector system shown in FIG. **1**A, wherein the electrical connector assembly is mated with the complementary electrical connector;

FIG. **7**B is an isolated view of a portion of FIG. **7**A;

FIG. **8**A is a cross-section of a top plan view of the electrical connector shown in FIG. **1**A aligned for mating with the complementary electrical connector shown in FIG. **1**A;

FIG. **8**B is a cross-section of a top plan view of the electrical connector shown in FIG. **1**A mated with the complementary electrical connector shown in FIG. **1**A;

FIG. **9** is a perspective view of the electrical connector shown in FIG. **2**A including signal contacts in accordance with another embodiment;

FIG. **10**A is a perspective view of a gender-neutral electrical connector constructed in accordance with yet another embodiment; and

FIG. **10**B is bottom plan view of the gender-neutral electrical connector shown in FIG. **10**A mated with a complementary gender neutral electrical connector.

DETAILED DESCRIPTION

For convenience, the same or equivalent elements in the various embodiments illustrated in the drawings have been identified with the same reference numerals. Certain terminology is used in the following description for convenience only and is not limiting. The words "left," "right," "front," "rear," "upper," and "lower" designate directions in the draw-

ings to which reference is made. The words "forward," "forwardly," "rearward," "inner," "inward," "inwardly," "outer," "outward," "outwardly," "upward," "upwardly," "downward," and "downwardly" refer to directions toward and away from, respectively, the geometric center of the object referred to and designated parts thereof. The terminology intended to be non-limiting includes the above-listed words, derivatives thereof and words of similar import.

Referring initially to FIGS. **1**A-B, in accordance with one embodiment, an electrical connector system **99** can include a first electrical connector assembly **100** and a second or complementary electrical connector assembly **200**. The electrical connector assembly **100** can include a first electrical connector **102** and a first electrical component such as a first substrate **104**, and the complementary electrical assembly **200** can include a second or complementary electrical connector **202** and a second electrical component such as a second or complementary substrate. The electrical connectors **102** and **202** can be configured to be mated with each other so as to establish an electrical connection, for instance an electrical connection that transfers power, between the electrical connectors **102** and **202**, and thus between the first and complementary electrical assemblies **100** and **200**, respectively. The electrical connector **102** can be configured to be mounted to the substrate **104** and the complementary electrical connector **202** can be configured to be mounted to the complementary substrate so as to establish an electrical connection between the substrates. The substrates can be provided as a backplane, midplane, daughtercard, or the like.

Referring also to FIGS. **2**A-D, the electrical connector **102** can include a first dielectric or electrically insulative connector housing **106** and at least one such as a plurality of electrical contacts **108** that are at least partially disposed within the connector housing **106**. The electrical contacts **108** can include power contacts that are configured to transmit electrical current. The electrical contacts **108** can include signal contacts that are configured to transmit data. In accordance with the illustrated embodiment, when the electrical connector **102** is mounted to the substrate **104** along a mounting direction, the electrical contacts **108** are placed in electrical communication with electrical traces of the substrate **104**. The complementary electrical connector **202** can include a second or complementary dielectric or electrically insulative connector housing **206** and at least one such as a plurality of complementary electrical contacts **208** that are supported by the complementary connector housing **206**. When the complementary electrical connector **202** is mounted to the complementary substrate, the electrical contacts **208** are placed in electrical communication with electrical traces of the complementary substrate. The electrical connector **102** can be configured to mate with the complementary electrical connector **202** along a mating direction M so as to establish an electrical connection between the first and second electrical contacts **108** and **208**, respectively, and thus also between the electrical traces of the substrate **104** and the complementary substrate. The plurality of electrical contacts **108** can be supported by the connector housing **106** and spaced apart from each other along a lateral direction A that is substantially perpendicular to the mating direction M.

Referring also to reference to FIGS. **3**A-**4**B, in accordance with the illustrated embodiment, the electrical connector **102** can be constructed as a right-angle receptacle connector that includes the connector housing **106**. The connector housing **106** includes a first housing body **110** that defines a first mating interface **112** and a first mounting interface **114** which are oriented substantially perpendicular with respect to each other so as to define the right-angle electrical connector **102**. It will be understood that the electrical connector **102** can be constructed as desired, for instance as a vertical connector such that the mating interface **112** is parallel with respect to the mounting interface **114**. The mounting interface **114** can be configured to be mounted onto a substrate and the mating interface **112** can be configured to mate with at least one complementary electrical connector along the mating direction M.

In accordance with the illustrated embodiment, the complementary electrical connector **202** can be constructed as a right-angle header connector that defines a second or complementary mating interface **212** and a second or complementary mounting interface **214** that extends substantially perpendicular to the complementary mating interface **212**. The mating interface **112** of the electrical connector **102** can be configured to mate with the complementary mating interface **212** of the complementary electrical connector **202**. The first and complementary mounting interfaces **114** and **214**, respectively, can be configured to mount onto underlying substrates, such as the substrate **104** and the complementary substrate. The mating interface **112** of the electrical connector **102** can include receptacle openings **116** that are defined by the connector housing **106**, such that the complementary electrical contacts **208** of the complementary electrical connector **202** can be received in the receptacle openings **116** when the electrical connector **102** is mated with the complementary electrical connector **202**.

As shown in the illustrated embodiment, the electrical connector **102** can be configured as a receptacle connector and the complementary electrical connector **202** can be configured as a header connector, such that the connector housing **106** is configured to receive the complementary connector housing **206** so as to mate the first and complementary electrical connectors **102** and **202**, respectively.

Various structures are described herein as extending horizontally along a first or longitudinal direction "L" and a second or lateral direction "A" that is substantially perpendicular to the longitudinal direction L, and vertically along a third or transverse direction "T" that is substantially perpendicular to the longitudinal and lateral directions L and A, respectively. As illustrated, the longitudinal direction "L" extends along a forward/rearward direction of the electrical connector **102**, and defines the mating direction M along which one or both of the electrical connector **102** and the complementary electrical connector **202** are moved relative to the other so as to mate the electrical connector assembly **100** with the complementary electrical connector assembly **200**, and thus to mate the electrical connector **102** with the complementary electrical connector **202**. For instance, the mating direction M of the illustrated electrical connector **102** is in a forward direction along the longitudinal direction L, and the electrical connector **102** can be unmated from the complementary electrical connector **202** by moving the electrical connector **102** in an opposed longitudinally rearward direction relative to the complementary electrical connector **202**. As illustrated, the electrical connector **102** can be moved relative to the substrate **104** along the transverse direction T that defines the mounting direction, and the lateral direction "A" extends along a width of the electrical connector **102**.

Thus, unless otherwise specified herein, the terms "lateral," "longitudinal," and "transverse" are used to describe the orthogonal directional components of various components. The terms "inboard" and "inner," and "outboard" and "outer" and like terms when used with respect to a specified directional component are intended to refer to directions along the directional component toward and away from the center of the apparatus being described. It should be appreciated that while

the longitudinal and lateral directions are illustrated as extending along a horizontal plane, and that while the transverse direction is illustrated as extending along a vertical plane, the planes that encompass the various directions may differ during use, depending, for instance, on the orientation of the various components. Accordingly, the directional terms "vertical" and "horizontal" are used to describe the electrical connector assembly **100** and its components as illustrated merely for the purposes of clarity and convenience, it being appreciated that these orientations may change during use.

With continuing reference to FIGS. **1-4**B, in accordance with the illustrated embodiment, the housing body **110**, and thus the connector housing **106**, defines a front end **110***a* and an opposed rear end **110***b* that is spaced from the front end **110***a* along the longitudinal direction L. The front end **110***a* can generally lie in a plane defined by the transverse and lateral directions T and A, respectively. The front end **110***a* can define the mating interface **112** that is configured to be mated with the complementary electrical connector **202** so as to place the electrical connector **102** in electrical communication with the complementary electrical connector **202**. The housing body **110**, and thus the connector housing **106**, can further include a top end **110***c* and an opposed bottom end **110***d* that is spaced from the top end **110***c* along the transverse direction T. For instance, the top end **110***c* can be spaced from the bottom end **110***d* in an upward direction that is substantially parallel to the transverse direction T. Thus, the bottom end **110***d* can be spaced from the top end **110***c* in a downward direction that is substantially parallel to the transverse direction T. The top end **110***c* can extend from the front end **110***a* to the rear end **110***b*. The bottom end **110***d* can define the mounting interface **114** that is configured to be mounted to the substrate **104**. The bottom end **110***d* can generally lie in a plane defined by the longitudinal and lateral directions L and A, respectively. The connector housing **106**, and thus the electrical connector **102**, can further include first and second opposed sides **110***e* and **110***f*, respectively, that are spaced from each other along the lateral direction A. While the lateral and longitudinal directions A and L, respectively, extend horizontally and the transverse direction T extends vertically in accordance with the illustrated orientation of the electrical connector assembly **100**, it should be appreciated that the orientation of the electrical connector assembly can vary as desired.

Referring to FIGS. **3**A-C, the electrical contacts **108** can each define a mating portion **118**, a mounting portion **120**, and an intermediate portion **122** that extends between the mating portion **118** and the mounting portion **120**. The mating portions **118** can be configured to mate with the complementary electrical contacts **208** of the complementary electrical connector **202** that is to be mated with the electrical connector **102**. Thus, the mating portion **118** can be configured to mate with a complementary electrical contact of at least one complementary electrical connector when the connector housing **106** is mated with the at least one complementary electrical connector.

The mounting portions **120** can be configured to electrically connect to the substrate **104** when the connector housing **106** is mounted onto the substrate **104**. The mounting portion **120** can include one or more mounting terminals **124** that are disclosed proximate to the mounting interface **114** and are configured to electrical connect to the substrate **104**. In one embodiment, the mounting terminals **124** are inserted through plated through-holes **126** of the substrate **104** and the mounting terminals **124** define press-fit tails. The through-holes **126** can define mounting locations **128** that define a footprint constructed as described with respect to the footprint **130** described below with respect to FIG. **5-6**. Alternatively, the mounting terminals **124** can be surface-mounted to the substrate **104**. The mounting terminals **124** can further be soldered to the substrate **104** as desired. Thus, the electrical contacts **108** can place the substrate **104** in electrical communication with the complementary electrical connector **202** when the complementary electrical connector **202** is mated with the electrical connector assembly **100**. The electrical contacts **108** can be configured as power contacts that transmit electrical power between the substrate **104** and a complementary electrical component such as the electrical connector **202**. Thus, the electrical connector **102** can be configured as a power connector.

In accordance with the illustrated embodiment, the mating portion **118** extends forward from the intermediate portion **122** along the longitudinal direction L and terminates at a mating end **132**, and the mounting terminals **124** extend downward from the intermediate portion **122** along the transverse direction and terminate at a mounting end **134**. The mounting ends **134** can be configured to be placed in electrical communication with the substrate **104** when the mounting interface **114** is mounted to the substrate **104**. The illustrated mating portions **118** extend in a direction substantially perpendicular to the mounting terminals **124** such that the electrical contacts **108** can be referred to as right-angle contacts. Alternatively, the electrical contacts **108** can be constructed as a "vertical" or "mezzanine" arrangement whereby the mating portions **118** extend in a direction parallel to the mounting terminals **124**.

Because the mating ends **132** of the electrical contacts **108** are configured to receive their complementary contacts **208**, they can be referred to as "receptacle" contacts, and the electrical connector **102** can be referred to as a "receptacle" connector.

Referring to FIGS. **3**A-C and **7**A-**8**B, each of the electrical contacts **108** includes a first side wall **136** and a second side wall **138** that is spaced from the first side wall **136** along the lateral direction A so as to define a distance, which can be referred to as a third distance d_3. The mounting portion **120** of each electrical contact **108** includes at least one pair **125** of mounting terminals **124**. The mounting terminals **124** in each pair **125** are aligned with each along the longitudinal direction L, and spaced from each other along the lateral direction A. The mounting portion **120** further defines at least one neck, for instance first and second necks **140***a* and **140***b*, that extend between the first and second side walls **136** and **138**, respectively, and first and second pluralities of mounting terminals **124***a* and **124***b*, respectively. Thus, each pair **125** of mounting terminals **124** includes a first mounting terminal **124***a* and a second mounting terminal **124***b*. The first and second necks **140***a* and **140***b* can be curved or angled inward along the downwardly transverse direction T such that the first and second mounting terminals **124***a* and **124***b* in each pair **125** are spaced apart from each other a shorter distance along the lateral direction A than the first and second side walls **136** and **138** are spaced from each other along the lateral direction A. For instance, the electrical contact **108** can include first and second pluralities of mounting terminals **124***a* and **124***b* can be spaced apart from each along the lateral direction A to define a distance, which can be referred to as a fourth distance d_4, that is less than the third distance d_3. The electrical contact **108** can further include the first neck **140***a* that extends between the first side wall **136** and the first plurality of mounting terminals **124***a*, and the second neck **140***b* that extends between the second side wall **138** and the second plurality of mounting terminals **124***b*.

The mounting terminals **124** can define through-hole, solder-to-board pins (as shown in FIG. **3**B), press fit pins (as shown in FIG. **3**C) or surface mount tails, or any suitable alternative structure configured to electrically connect to the substrate **104**. The first and second side walls **136** and **138** can be connected by one or more bridge elements, for instance a first bridge element **142** and a second bridge element elements **144**, and thus electrical contacts **108** can each be U-shaped, although it will be understood that the electrical contacts **108** can be alternatively shaped as desired. A medial space **146**, for instance adapted for air flow, can be defined between the first and second side walls **136** and **138**, respectively. It will be understood that the electrical contact **108** can be stamped or otherwise formed as a single piece from a strip of suitable contact materials such as phosphor bronze alloys, beryllium copper alloys, or any suitable alternative electrically conductive material.

The housing body **110**, and thus the connector housing **106**, can define receptacle openings **116** that are configured to receive at least one electrically conductive component along the longitudinal direction L, which can be referred to as the mating direction M. The openings **116** can be disposed at the front end **110***a*. The electrical contacts **108** can be supported by the connector housing **106** and can be configured to contact the complementary electrical contacts **208** when the complementary electrical connector **202** is received in the openings **116**. In accordance with the illustrated embodiment, the receptacle openings **116** are disposed at the front end **110***a* of the connector housing **106**, thus the front end **110***a* of the connector housing can define the openings **116**. The connector housing can further define first and second electrically insulative arms **150***a* and **150***b* that are spaced apart from each other along the lateral direction A and that are supported by the housing body **110**. The first and second arms **150***a* and **150***b* can abut the first and second side walls **136** and **138**, respectively, such that the first and second side walls **136** and **138** are at least partially disposed within the receptacle opening **116**. Thus, the first and second arms **150***a* and **150***b* can further define the receptacle opening **116**. In particular, the mating portion **118** of each electrical contact **108** can be disposed within the opening **116** such that the mating portion **118** contacts the complementary electrical contact **208** when the complementary electrical connector **202** is received in the receptacle opening **116**. The arms **150***a* and **150***b* can extend from the housing body **110** forwardly along the longitudinal direction L. Alternatively, the arms **150***a* and **150***b* can be monolithic with the housing body **110**.

The first arm **150***a* can define a first arm body **153***a* and a first barb **151***a* that extends along the lateral direction A from the arm body **153***a* so as to be disposed in front of the mating end **132** along the longitudinal direction L. Similarly, the second arm **150***b* can define a second arm body **153***b* and a second barb **153***b* that extends along the lateral direction A from the arm body **153***b* so as to be disposed in front of the mating end **132** along the longitudinal direction L. Thus, the barbs **151***a* and **151***b* can be disposed at the front end **110***a* of the connector housing **106**, and barbs **151***a* and **151***b* can contact the mating end **132** along the lateral direction A such that the mating ends **132** are touch proof, and thus the mating ends **132** are blocked from human contact or humans are otherwise prevented from touching the mating ends **132** with their fingers. As used herein, touch-proof can also refer to compliance with a standardized test that is published in IEC 60950, which verifies that contact parts, such as mating ends or mounting ends, cannot be touched by a test finger. Thus, the mating ends **132** can be touch-proof such that the mating ends **132** cannot be touched by a test finger, which represents a human finger, from every reasonable position. Further, at least one arm, for instance the first and second arms **150***a* and **150***b*, can be supported by the housing body **110**. The at least one arm can extend beyond the mating portions **118** in the mating direction M such that the mating portions **118** terminate at a location **152** along the mating direction M that is disposed inward with respect to a location **154** in which the arm terminates along the mating direction M.

With particular reference to FIGS. **7**A-**8**B, a first arm **150***a* that abuts a first electrical contact **108** can be spaced from a second arm **150***b* that abuts a second electrical contact **108** along the lateral direction so as to define a gap **160**. The gap **160** can be configured to receive a portion of the complementary connector housing **206** when the electrical connector **102** is mated with the complementary electrical connector **202**. For instance, the complementary connector housing **206** can define a wall **222** that extends beyond the complementary electrical contacts **208** along the mating direction M such that the complementary contacts are touch proof, and the wall **222** can be received by the gap **160** so that the complementary electrical contacts **208** can electrically connect to the electrical contacts **108** when the electrical connector **102** is mated with the complementary electrical connector **202**. Thus, the complementary connector housing **206** can be received in the gap **160** that extends into the housing body **106**.

Thus, the connector housing **106** can include an inner surface **107** that defines at least one opening **116** such that at least one of the plurality of electrical contacts **108** are disposed in the opening. The inner surface **107** can at least substantially surround the at least one of the plurality of electrical contacts **108**, and the inner surface **107** can extend out from the housing body **110** along the mating direction M past the mating end **132** of the at least one of the plurality of electrical contacts **108**, wherein at least one of the electrical contacts terminates at the mating end **132**. Thus, the electrical contacts **108**, and thus the electrical connector **102**, can be touch-proof at the mating end **132**. Thus, the connector housing **106** can extend beyond the mating ends **132** of the electrical contacts **108** along the mating direction M.

With particular reference to FIGS. **4**A-B, the connector housing **106**, and thus the electrical connector **102**, can include at least one electrically insulative fin, for instance a plurality of electrically insulative fins **156** that are supported by the housing body **110**. It will be understood that the fins **156** can be monolithic with the housing body **110** or attached to the housing body **110** as desired. Each fin **156** can be disposed between the electrical contacts **108** along the lateral direction A. For instance, at least one fin **156** can be disposed between at least first and second electrical contacts **108** of the plurality of electrical contacts along the lateral direction A. At least one fin, for instance each fin **156**, can extend downward with respect to the mounting portions **120**, and in particular the mounting ends **134**, such that the mounting ends **134** are touch proof and the at least one fin **156** is received by the substrate **104** before the mounting portions are received by the substrate **104** when the electrical connector **102** is mounted to the substrate **104**. Thus, the electrical contacts **108** can be touch proof at the mating ends **132** and the mounting ends **134** in accordance with the IEC 60950 test procedure. The fins **156** can connect to the bottom end **110***d* of the housing body **110**. Thus, the mating ends **132** and the mountings ends **134** can be touch-proof such that the mating ends **132** and the mounting ends **136** cannot be touched by a test finger, which represents a human finger, from every reasonable position.

Thus, the electrical contacts **108** can include first and second electrical contacts **108** that are supported by the connec-

tor housing **106** and spaced apart from each other along the lateral direction that is substantially perpendicular with respect to the longitudinal and transverse directions L and T, respectively. Each of the first and second electrical contacts **108** can define at least one mounting terminal **124** that is placed in electrical communication with the substrate **104** when the first and second electrical contacts **108** are mounted to the substrate **104**. Further, the connector housing **106** can define the electrically insulative fin **156** that can be disposed between the first and second electrical contacts **108** along the lateral direction A. Thus, the fin **156** can define a maximum height of the electrical connector **102** along the transverse direction T. For instance, the bottom end **110***d* can be spaced from the top end **110***c* in a downward direction that is substantially parallel to the transverse direction T, and the mounting terminals **124** can terminate at the mounting end **134** along the downward direction and the fin **156** can terminate at a location that is spaced from the mounting end **134** in the downward direction. Thus, the fin **156** can extend through the slot **148** in the substrate **104** in the downward direction when the electrical connector **102** is mounted to the substrate **104**.

Further, in accordance with the illustrated embodiment, referring particularly to FIG. **2**D, the mounting portion **120** of each of the first and second electrical contacts **108** can terminate at the mounting end **134** that is spaced from the housing body **110** a first distance d_1 along the transverse direction T that is perpendicular to each of the mating direction M and the lateral direction A. The at least one fin **156** can extend from the housing body **110** along the transverse direction T and terminate at a distal end **157** that is spaced from the housing body a second distance d_2 along the transverse direction T, wherein the second distance d_2 is no less than the first distance d_1. For instance, the second distance d_2 can be greater than the first distance d_1. Thus, the fin **156** can be configured to be inserted at least into, for instance through, the substrate **104** before the mounting portions **120** are inserted at least into, for instance through, the substrate **104** when the electrical connector **102** is mounted to the substrate **104**. Thus, the connector housing **106** can define an electrically insulative fin **156** that extends down from the housing body **110** past the mounting ends **134** along the transverse direction T, and the fin **156** can define a first dimension in the longitudinal direction L and a second dimension in a lateral direction A that is perpendicular to each of the longitudinal direction L and the transverse direction T, and the first dimension can be least five times greater than the second dimension. For instance,

The fin **156** can be longer in a major direction that includes at least one of the longitudinal direction L and the lateral direction A with respect to a minor direction that is perpendicular to the major direction and does not include the transverse direction T. For instance, the major direction can include each of the longitudinal direction L and the lateral direction A. Thus, the fin **156** can be longer in one of the longitudinal and the lateral directions L and A than the other of the longitudinal direction L and the lateral direction A. Further, the fin **156** can define a first dimension in the one of the longitudinal and the lateral directions L and A, and a second dimension in the other of the longitudinal and the lateral directions L and A, and the first dimension can be least five times greater than the second dimension. In accordance with the illustrated embodiment, the first dimension is in the longitudinal direction L. Alternatively, it will be understood that the first dimension can be the lateral direction.

Referring to FIG. **6**, the fins **156** define a fin width W_1 along the lateral direction A that is less than a width of a slot **148** of the substrate **104** such that that the slot **148**, and thus the substrate **104**, can receive the fin **156** such that the fin **156** can extend through the substrate **104**. The plurality of electrical contacts **108** can define pairs of electrical contacts **108** such that each pair of electrical contacts **108** includes a first electrical contact and a second electrical contact disposed immediately adjacent the first electrical contact along the lateral direction A such that no other electrical contact is disposed between the first and second electrical contacts. Thus, in accordance with the illustrated embodiment, only a single fin **156** can be disposed between each pair of electrical contacts along the lateral direction A. It will be understood that the number of fins disposed between a pair of immediately adjacent electrical contacts **108** can vary as desired. For instance, the fin **156** can be disposed between first and second ones of immediately adjacent electrical contacts along the lateral direction A, wherein no other ones of the electrical contacts **108** are disposed between the immediately adjacent electrical contacts **108** along the lateral direction A.

Referring to FIGS. **5-6**, the substrate **104** can include a plurality of mounting locations **128**, which can be provided as plated through holes **126** and the slots **148**. The plated through holes **126** can be configured to receive the mounting terminals **124** of the electrical contacts **108** as described above. The slots **148** can be configured to receive a portion of the connector housing **106**, for instance the fins **156**. The mounting terminals can define any geometrical cross-sectional shape as desired. Further, the fins **156** can define any geometrical cross-sectional shape as desired.

The mounting terminals **124** of the electrical contacts **108** defines a footprint **130** taken from a portion of a bottom plan view of the electrical connector **102**. The illustrated footprint **130** is illustrated as including three electrical contacts **108**, though any number of electrical contacts **108** can be provided as desired. The mounting terminals **124** of the electrical contacts **108** are arranged in a plurality of columns. For instance, the first mounting terminals **124***a* of each electrical contact **108** are arranged in a first column (column 1) of the respective contact **108**, and the second mounting terminals **124***b* of each electrical contact **108** are arranged in a second column (column 2) of the respective contact **108**. Columns 1 and 2 of each electrical contact **108** are disposed laterally adjacent each other and extend along a direction, for instance the longitudinal direction L, that is substantially parallel to each other. The electrical contacts **108** are further arranged such that the first column (C_1) of one electrical contact **108** is disposed laterally adjacent to the second column (C_2) of its adjacent electrical contact **108**, and the fin **156** is disposed between the first column (C_1) of one electrical contact **108** and the second column (C_2) of its adjacent electrical contact **108**.

Each electrical contact **108** can define a centerline disposed at the midpoint between the first and second side walls **136** and **138** along the lateral direction A. The spacing between the centerlines of adjacent electrical contacts **108** may be referred to as the column pitch CP. The first and second columns can define a centerline disposed at the midpoint between the first and second columns along the lateral direction A. The spacing between the centerlines of adjacent column midpoints may be substantially equal to the column pitch CP. In the illustrated embodiment, the column pitch CP can be between 1 and 7 mm, such as between 5 and 6 mm, such as between, for instance approximately 5.0 mm or more particularly 5.08 mm. It should be further appreciated the electrical contacts **108** can be arranged and constructed so as to define any column pitch as desired.

One or more, up to all as illustrated in FIGS. **5-6**, of the first and second mounting terminals **124***a* and **124***b* of each electrical contact **108** are aligned with the respective like terminals **124***a* and **124***b* of the electrical contacts **108**, arranged in

rows R_1-R_4. A first or upper mounting location **128'** is disposed in a first (R_1), and a second or lower mounting location **128"** is disposed in a fourth row (R_4). In accordance with illustrated embodiment, the slots **148** define a distance along the longitudinal direction that is greater than the distance along the longitudinal direction L between the uppermost surface of the upper mounting location **128'** and lowermost surface of the lower mounting location **128"**. Thus, as illustrated the fins **156** can define a length along the longitudinal direction L that is greater than the distance between a mounting terminal in row 1 and a mounting terminal in row 4 along the longitudinal direction L. Thus, the fins **156** can increase a creepage distance CD (see FIG. **6**) as desired. The fins **156** can increase the creepage distance CD as compared to electrical connectors that do not include fin. For instance, in one embodiment, the creepage distance CD can be between 4 mm and 8 mm, for instance 4.91 mm. It should be further appreciated that the fins **156** can be constructed so as to define any creepage distance CD as desired.

Thus, the mounting terminals **124***a* and **124***b* of adjacent columns 1 and 2 of adjacent electrical contacts **108** are spaced apart a greater creepage distance than if there is no slot **148** disposed between them along the lateral direction A. Thus, the illustrated connector **102** provides increased creepage distance between the mounting terminals without increasing the footprint of the mounting interface of the connector with respect to a similarly constructed connector that does not include the fins **156**.

It should further be appreciated that the increased creepage distance between the mounting terminals **124***a* and **124***b* allows the electrical contacts **108** to carry an increased working voltage (for instance 400V or greater) with respect to conventional terminals, while at the same time reducing or preventing arcing across the mounting terminals **124***a* and **124***b* during operation. The electrical contacts **108** can further carry greater current than other contacts, and the electrical contacts **108** are configured to be touch-proof.

Stated yet another way, the electrical connector **102** can include an electrical housing **106** and a first electrical contact **108** comprising a first mating end **132** and a plurality of first mounting terminals **124** each having a respective first mounting end **134**. The second electrical contact **108** can be positioned immediately adjacent to the first electrical contact **108**, the second electrical contact **108** comprising a second mating end **132** and a plurality of second mounting terminals **124** each having a respective second mounting end **134**. The first mounting ends **134** of the first mounting terminals **124** can configured to extend from the substrate **104** and remain exposed, and the second mounting terminals **134** can configured to extend from the substrate **104** and remain exposed. Further, the electrical connector **102** can be touch proof as described above, for instance touch proof according to the IEC 60950 test finger probe procedure, at the first mating end **132**, at the second mating end **132**, at the first mounting end **134** of each of the first mounting terminals **124**, and at the second mounting end **134** of each of the second mounting terminals **124**. The electrical housing **106** can further comprise an electrically insulative fin **156** positioned between the first mounting terminals **124** and the second mounting terminals **124** and the electrically insulative fin **156** can extend in a length beyond the first mounting ends **134** of the first mounting terminals **124** and the second mounting ends **134** of the second mounting terminals **124**. The electrical housing **106** can extend beyond the first mating end **132** of the first electrical contact **108** and the second mating end **132** of the second electrical contact **108**.

Referring to FIG. **9**, an electrical connector **102***a* includes the electrical connector **102** signal contacts **108***a* that are configured to transmit data. The signal contacts **108***a* can be touch proof. Further, referring to FIGS. **10**A and **10**B, it will be understood that the electrical connector **102** can be configured as a gender-neutral electrical connector **102***b* in accordance with an embodiment. Referring to FIG. **10**, the gender-neutral electrical connector **102***b* includes electrical contacts **108***b* that alternate between a receptacle electrical contact **109***a* and a header or plug receptacle contact **109***b* along the lateral direction A such that mating forces along the mating direction M, which can be parallel with the longitudinal direction L, are substantially balanced. Each of the receptacle and header electrical contacts **109***a* and **109***b* are configured as touch-proof. Further, the gender-neutral electrical connector **102***b* can be configured such that no power contacts touch the housing **106***b* of the electrical connector **102***b*.

In operation, a method of establishing an electrical connection with an electrical connector that has 1) a connector housing including a housing body and a fin that extends out from the housing body, the housing body defining a mating interface configured to mate with a complementary connector housing of a complementary electrical connector, and a mounting interface configured to be mounted onto a substrate, and 2) a plurality of electrical contacts supported by the connector housing, each of the electrical contacts defining a mounting portion and a mating portion, can include the bringing the connector housing toward the substrate. During the bringing step, the fin can be inserted at least into a slot in the substrate. After the inserting step and during the bringing step, the mounting portion can be inserted into the substrate so as to place the electrical contacts in electrical communication with the substrate. A relative movement between the electrical connector and the complementary electrical connector can be established along the mating direction so as to cause the mating portions of the electrical contacts to mate with complementary electrical contacts of the complementary electrical connector. The complementary connector housing can be received in a gap that extends into the housing body.

In accordance with one embodiment and in accordance with the description above, a method can include offering for sale a first electrical connector, for instance the electrical connector **102**, that includes at least one electrically insulative fin, for instance a plurality of electrically insulative fins **156**.

The embodiments described in connection with the illustrated embodiments have been presented by way of illustration, and the present invention is therefore not intended to be limited to the disclosed embodiments. Furthermore, the structure and features of each the embodiments described above can be applied to the other embodiments described herein, unless otherwise indicated. Accordingly, the invention is intended to encompass all modifications and alternative arrangements included within the spirit and scope of the invention, for instance as set forth by the appended claims.

What is claimed:

1. An electrical connector comprising:

a dielectric connector housing including a housing body that defines a mounting interface configured to be mounted onto a substrate and a mating interface configured to mate with at least one complementary electrical connector along a mating direction;

a plurality of electrical contacts supported by the connector housing and spaced apart from each other along a lateral direction that is substantially perpendicular to the mating direction, the electrical contacts including 1) a mat-

ing portion configured to mate with a complementary electrical contact of the at least one complementary electrical connector when the connector housing is mated with the at least one complementary electrical connector, and 2) a mounting portion configured to electrically connect to the substrate when the connector housing is mounted onto the substrate;

at least one electrically insulative fin supported by the housing body, the at least one fin disposed between at least first and second electrical contacts of the plurality of electrical contacts along the lateral direction,

wherein 1) the mounting portion of each of the first and second electrical contacts terminates at a mounting end that is spaced from the housing body a first distance along the transverse direction that is perpendicular to each of the mating direction and the lateral direction, 2) the at least one fin extends from the housing body along the transverse direction and terminates at a distal end that is spaced from the housing body a second distance along the transverse direction, and 3) the second distance is no less than the first distance.

2. The electrical connector as recited in claim **1**, wherein the second distance is greater than the first distance.

3. The electrical connector as recited in claim **2**, wherein the at least one fin is configured to be inserted at least into the substrate before the mounting portions are inserted at least into the substrate when the electrical connector is mounted to the substrate.

4. The electrical connector as recited in claim **1**, wherein the at least one fin is longer in a major direction that includes at least one of the mating direction and the lateral direction with respect to a minor direction that is perpendicular to the major direction and does not include the transverse direction.

5. The electrical connector as recited in claim **4**, wherein the major direction includes each of the mating direction and the lateral direction.

6. The electrical connector as recited in claim **1**, wherein the at least one fin is longer in one of the mating and the lateral directions than the other of the mating direction and the lateral direction.

7. The electrical connector as recited in claim **6**, wherein the at least one fin defines a first dimension in the one of the mating and the lateral directions, and a second dimension in the other of the mating and the lateral directions, and the first dimension is at least five times greater than the second dimension.

8. The electrical connector as recited in claim **7**, wherein the first dimension is in the mating direction.

9. The electrical connector as recited in claim **7**, wherein the first dimension is in the lateral direction.

10. The electrical connector as recited in claim **1**, wherein the at least one fin is monolithic with the housing body.

11. The electrical connector as recited claim **1**, wherein the at least one fin is attached to the housing body.

12. The electrical connector as recited in claim **1**, the electrical connector further comprising at least one electrically insulative arm supported by the housing body, the at least one arm extending beyond the mating portions in the mating direction such that the mating portions terminate at a location along the mating direction that is disposed inward with respect to a location in which the arm terminates along the mating direction.

13. The electrical connector as recited in claim **1**, wherein the plurality of electrical contacts define pairs of electrical contacts, each pair of electrical contacts including a first electrical contact and a second electrical contact disposed immediately adjacent the first electrical contact such that no other electrical contact is disposed between the first and second electrical contacts.

14. The electrical connector as recited in claim **13**, wherein a single fin is disposed between each pair of electrical contacts along the lateral direction.

15. The electrical connector as recited in claim **1**, wherein each of the electrical contacts comprise 1) first and second side walls spaced apart from each other along the lateral direction to define a first distance, 2) first and second pluralities of mounting terminals spaced apart from each along the lateral direction to define a second distance that is less than the first distance, 3) a first neck that extends between the first side wall and the first plurality of mounting terminals, and 4) a second neck that extends between the second side wall and the second plurality of mounting terminals.

16. The electrical connector as recited in claim **1**, wherein the electrical connector is a power connector.

17. An electrical connector configured to mate with at least one complementary electrical connector, and further configured to mount to a substrate along a mounting direction, the electrical connector comprising:

an electrically insulative connector housing including a housing body that defines a front end, a rear end opposite the front end along a longitudinal direction, a top end that extends from the front end to a rear end, and a bottom end spaced from the top end along a transverse direction that is perpendicular with respect to the longitudinal direction, the bottom end defining a mounting interface that is configured to be mounted onto the substrate;

a plurality of electrical contacts supported by the connector housing, each of the electrical contacts defining at least one mounting end that extends down from the connector housing along the transverse direction,

wherein 1) the connector housing defines a electrically insulative fin that extends down from the housing body past the mounting ends along the transverse direction, and 2) the fin defines a first dimension in the longitudinal direction and a second dimension in a lateral direction that is perpendicular to each of the longitudinal direction and the transverse direction, and the first dimension is at least five times greater than the second dimension.

18. The electrical connector as recited in claim **17**, wherein the fin is disposed between first and second ones of immediately adjacent electrical contacts along the lateral direction, and no other ones of the electrical contacts are disposed between the immediately adjacent electrical contacts along the lateral direction.

19. The electrical connector as recited in claim **17**, wherein the connector housing includes an inner surface that defines at least one opening such that at least one of the plurality of electrical contacts are disposed in the opening, the inner surface at least substantially surrounds the at least one of the plurality of electrical contacts, and the inner surface extends out from the housing body along the mating direction past a mating end of the at least one of the plurality of electrical contacts, the at least one of the electrical contacts terminating at the mating end.

20. The electrical connector as recited in claim **19**, wherein the bottom end is spaced from the top end in a downward direction that is along transverse direction, and wherein the electrical contact further terminates at the mounting end along the downward direction and the fin terminates at a location that is spaced from the mounting end along the downward direction.

21. The electrical connector as recited in claim 17, wherein the fin extends through a slot in the substrate in the downward direction when the electrical connector is mounted to the substrate.

22. A method of establishing an electrical connection with an electrical connector that has 1) a connector housing including a housing body and a fin that extends out from the housing body, the housing body defining a mating interface configured to mate with a complementary connector housing of a complementary electrical connector, and a mounting interface configured to be mounted onto a substrate, and 2) a plurality of electrical contacts supported by the connector housing, each of the electrical contacts defining a mounting portion and a mating portion, the method comprising the steps of:

bringing the connector housing toward the substrate;

during the bringing step, inserting the fin at least into a slot in the substrate; and

after the inserting step and during the bringing step, inserting the mounting portion into the substrate so as to place the electrical contacts in electrical communication with the substrate.

23. The method as recited in claim 22, the method further comprising the step of establishing a relative movement between the electrical connector and the complementary electrical connector along a mating direction so as to cause the mating portions of the electrical contacts to mate with complementary electrical contacts of the complementary electrical connector.

24. The method as recited in claim 22, the method further comprising the step of receiving the complementary connector housing in a gap that extends into the housing body.

* * * * *